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SURGICAL CLIP WITH INTEGRAL SUTURE-SECURING MECHANISM

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Description

SURGICAL CLIP WITH INTEGRAL SUTURE-SECURING MECHANISM

Technical Field

The present invention relates to surgical clips, and more particularly to surgical clips with an integral suture-securing mechanism to engage the ends of a suture to maintain a desired amount of tension on the suture. Yet more particularly, the present invention relates to an improved surgical clip that is provided with a suture-securing mechanism integral to the legs of the clip that serve to secure the ends of a suture.

Background Art

Laparoscopic, endoscopic, and other minimally invasive surgical techniques enable surgeons to perform fairly complicated procedures through relatively small entry points in the body. The term "laparoscopic" refers to surgical procedures performed on the interior of the abdomen, while the term "endoscopic" refers more generally to procedures performed in any portion of the body. Endoscopic surgery involves the use of an endoscope, which is an instrument permitting the visual inspection and magnification of a body cavity. The endoscope is inserted into a body cavity through a cannula extending through a hole in the soft tissue protecting the body cavity. The hole is made

with a trocar, which includes a cutting instrument slidably and removably disposed within a trocar cannula. After forming the hole, the cutting instrument can be withdrawn from the trocar cannula. A surgeon can then perform diagnostic and/or therapeutic procedures at the surgical site with the aid of specialized medical instruments adapted to fit through the trocar cannula.

Some known advantages of minimally invasive surgical techniques include reduced trauma to the patient, reduced likelihood of infection at the surgical site, and lower overall medical costs. Accordingly, minimally invasive surgical techniques are being applied to an increasingly wider array of medical procedures.

Surgical procedures often involve using sutures to hold tissue together while the tissue heals. Tension is applied to the suture to pull the tissue together and the suture is secured by tying the free ends of the suture to form a knot. The knotted ends prevent the suture from prematurely coming free from the suture site. However, once the ends of a suture are knotted, it has proven difficult to adjust the tension of the suture without removing the knot, such as by cutting the suture. Moreover, suturing internal tissue during minimally invasive procedures can prove challenging due to the limited amount of space available to perform the rather complex manipulations required to knot the suture.

Accordingly, there is a need to provide a mechanism to secure the free ends of a suture while maintaining a desired amount of tension on the suture.

Summary of the Invention

In accordance with the present invention, a polymeric surgical clip having a first and second leg member is provided. Each leg member has an inner surface and an opposite outer surface. A resilient hinge joins the first leg member and the second leg member at their proximal ends, with the first and second leg members being oriented such that the inner surface of the first leg member is in opposition to the inner surface of the second leg member. A deflectable hook member terminates the distal end of the first leg member and is curved toward the second leg member. A locking portion terminates the distal end of the second leg member and is complementary to the hook member such that when the first and second leg members are moved about the hinge from an open position to a closed position, the hook member deflects about the distal end of the second leg member to lock the clip in the closed position. A ridge is formed along the inner surface of either the first or second leg members and a groove is formed along the inner surface of the other leg. The groove is aligned in opposition to the ridge such that the ridge and groove cooperate when the clip is in the closed position to capture a portion of a suture and maintain a desired level of tension on the suture. The ridge includes an eyelet that extends through the ridge and engages a portion of the suture.

The surgical clip of the present invention is preferably made of polymeric material and accordingly minimizes interference with high technology diagnostic modalities such as CAT SCAN, MRI and MRS. At the same time, the clip is nearly as small as comparable metal clips while maintaining sufficient strength and possessing high security in the clip's latching mechanism in the closed

position clamping the vessel. The surgical clip is configured to provide a secure means of handling an application to avoid premature release from the applier of the clip.

It is an object of the present invention to provide a mechanism for securing the ends of a suture while maintaining a desired amount of tension on the suture.

Some of the objects of the invention having been stated hereinabove, other objects will become evident as the description proceeds when taken in connection with the accompanying drawings as best described hereinbelow.

Brief Description of the Drawings

Figure 1 is an enlarged perspective view of a surgical clip according to one embodiment of the present invention;

Figure 2 is an enlarged side elevation view of the surgical clip according to one embodiment of the present invention;

Figure 2-A is an enlarged side elevation view of the surgical clip according to another embodiment of the present invention;

Figure 3 is an enlarged, partially sectioned view of the surgical clip viewed along line 3—3 in Figure 2;

Figure 4 is an enlarged, fragmentary perspective view of the ridge and groove portions of the surgical clip according to one embodiment of the present invention;

Figure 5 is a vertical cross-sectional view of the ridge and groove portions of the surgical clip according to one embodiment of the present invention;

Figure 6 is a vertical cross-sectional view of the clip applied to a suture;

Figure 7 is an enlarged, fragmentary perspective view of the ridge and groove portions of the surgical clip according to another embodiment of the present invention;

Figure 8 is a vertical cross-sectional view of the ridge and groove portions of the surgical clip according to another embodiment of the present invention; and

Figure 9 is a vertical cross-sectional view of the clip applied to a suture.

Detailed Description of the Invention

Referring to Figure 1 through Figure 3, an example is illustrated of an asymmetric surgical clip generally designated **100** that is suitable for use in conjunction with the present invention. Clip **100** and others of similar design are particularly useful as suture clips that may secure the free ends of a suture. Clip **100** may be constructed from any suitable biocompatible material, such as certain metals and polymers. However, the present invention is particularly suitable for practice with polymeric clips. Thus, clip **100** preferably comprises a one-piece integral polymeric body formed from a suitably strong biocompatible engineering plastic, such as the type commonly used for surgical implants. Examples include polyethylene terephthalate (PET), polybutylene terephthalate

(PBT), polyoxymethylene, or other thermoplastic materials having similar properties that can be injection-molded, extruded or otherwise processed into like articles.

Figure 1 is an enlarged perspective view of the surgical clip of the present invention. The body of clip **100** includes a first or outer leg, generally designated **102**, and a second or inner leg, generally designated **104**. First and second legs **102** and **104** are joined at their proximal ends by an integral hinge section, generally designated **106**. First and second legs **102** and **104** have complementary arcuate profiles. Thus, first leg **102** has a concave inner surface **108** and a convex outer surface **110**, and second leg **104** has a convex inner surface **112** and a concave outer surface **114**. Convex inner surface **112** of second leg **104** and concave inner surface **108** of first leg **102** have substantially matching radii of curvature.

Hinge section **106** has a continuous concave inner surface **116** and a continuous convex outer surface **118**. Concave inner surface **116** of hinge section **106** joins concave inner surface **108** of first leg **102** and convex inner surface **112** of second leg **104**. Convex outer surface **118** of hinge section **106** joins convex outer surface **110** of first leg **102** and concave outer surface **114** of second leg **104**. Curved slot **120** is located between curved hinge surfaces **116** and **118**, and is positioned closer to inner surface **116** than to outer surface **118**. Slot **120** extends completely through hinge section **106** from side to side and its opposite ends **122**, **124** extend into the proximal ends of first and

second legs **102** and **104**, respectively. Slot **120** provides added flexibility to hinge section **106**.

First leg **102** transitions to a curved, C-shaped hook section **126** at its distal end. Second leg **104** transitions to a pointed tip section **128** at its distal end. The distal portion of hook section **126** curves inwardly and points generally toward inner surface **116** of hinge **106**. The hook section **126** has a transverse beveled surface **130** and a concave inner surface **108** that define a latching recess **132**. The latching recess **132** is adapted for conformally engaging tip section **128** in the course of compressing clip **100** into a latched or locked position.

In accordance with the present invention, ridge **134** protrudes from a portion of inner surface **108** of first leg **102**. Ridge **134** is primarily oriented longitudinally along a portion of inner surface **108** of first leg **102**. As shown in Figure 2, which is an enlarged side elevation view of the suture clip of the present invention, the proximal and distal ends of ridge **134** may smoothly transition into the inner surface **108** of first leg **102**. Eyelet **136** extends through ridge **134** in a direction substantially perpendicular to the lengthwise orientation of ridge **134** and substantially parallel to the inner surface of first leg **102**. Eyelet **136** is sized large enough to permit the suture thread **T** to be inserted through eyelet **136**, for example with the assistance of a suture needle, yet still provide sufficient resistance to facilitate secure positioning of clip **100** along the suture.

Recessed groove **138** is formed longitudinally along a portion of inner surface **112** of second leg **104**. Groove **138** has a profile complementary to ridge **134** and is positioned opposite to ridge **134**. Ridge **134** and groove **138** form complementary parts of an interlocking mechanism. Accordingly, when clip **100** is compressed into a latched or locked position, ridge **134** fits within groove **138**. One would appreciate that groove **138** should be larger than ridge **134** to accommodate ridge **134** and the portion of the suture that passes through eyelet **136**.

As best shown in Figure 3, which is a view directed into the open concave side of clip **100** viewed along line 3—3 in Figure 2, clip **100** has parallel, opposed side surfaces **140**, **142** and **144**, **146**. Ridge **134** is approximately centered between side surfaces **140** and **142** of first leg **102**. Similarly, groove **138** is approximately centered between side surfaces **144** and **146** of second leg **104**. By centering groove **138** between side surfaces **144** and **146**, approximately equal amounts of clip material are on each of the lateral sides of groove **138** and help secure the suture. The width and length of ridge **134** is smaller than the width and length of groove **138**. As noted above, the larger dimensions of groove **138** can accommodate ridge **134** and the portion of the suture that passes through eyelet **136**. Although ridge **134** is preferably mounted on first leg **102**, an alternative embodiment contemplated by the applicants to be within the scope of the invention is to provide ridge **134** on second leg **104** and groove **138** on first leg **102** (see Figure 2-A).

Adjacent to the distal end of the first leg **102** and immediately inward of hook section **126**, cylindrical bosses **148** and **150** protrude perpendicular to each of the opposed side surfaces **140** and **142**. In the illustrated example of clip **100**, a bridge section **152** couples bosses **148** and **150** together. As evident in Figure 2, bosses **148** and **150** project outwardly beyond convex outer surface **110** of first leg **102**. At the distal end of second or inner leg **104**, cylindrical bosses **154** and **156** protrude perpendicular to each of the opposed side surfaces of inner leg **104** at tip section **122**. Bosses **154** and **156** of second leg **104** extend longitudinally forwardly beyond tip section **128**.

In the practice of securing a suture as understood by persons skilled in the art, clip **100** is designed to be compressed into a latched or locked position around a suture through the use of an appropriate clip applicator instrument, such as the type described in the aforementioned U.S. Patent No. 5,100,416 to Oh et al. The clip applicator instrument engages bosses **148**, **150**, **154** and **156** of clip **100** and pivots bosses **148**, **150**, **154** and **156** inwardly about hinge section **106**. This causes first and second legs **102** and **104** to close around the vessel, with convex inner surface **112** of second leg **104** and complementary concave inner surface **108** of first leg **102** contacting the outer wall of the vessel. Ridge **134** pushes a portion of the suture into groove **138**. Ridge **134** and groove **138** effectively secure the clip to the vessel and maintain a desired amount of tension on the suture after clip closure. Tip section **128** of second leg **104** then begins to contact hook section **126**. Further pivotal movement by the applicator instrument longitudinally elongates first leg **102**

and deflects hook section **126**, allowing tip section **128** to align with latching recess **132**. Upon release of the applicator instrument, tip section **128** snaps into and is conformably seated in latching recess **132**, at which point clip **100** is in its latched condition. In the latched condition, tip section **128** is engaged between concave inner surface **108** and beveled surface **130**.

Figure 4 is an enlarged, fragmentary perspective view of the ridge **134** and groove **138** portions of clip **100**. One would appreciate that the proximity of ridge **134** and groove **138** suggests that clip **100** is in the process of being compressed into the closed position. Both ends of suture thread **T** are threaded through eyelet **136** by, for example, inserting a suture needle through eyelet **136**, suturing the tissue, and again inserting the suture needle through eyelet **136**.

Figure 5 is an enlarged, vertical cross-sectional view of the ridge **134** and groove **138** portions of clip **100** as viewed from the open end of clip **100**, as in Figure 3. One would appreciate that the proximity of ridge **134** and groove **138** suggests that clip **100** is in the process of being compressed into the closed position. Figure 5 shows the lateral alignment of ridge **134** and groove **138**.

Figure 6 is an enlarged, vertical cross-sectional view of clip **100** engaged around a portion of suture thread **T**. In the area where clip **100** is applied to suture thread **T**, ridge **134** pushes suture thread **T** into groove **138**. The portion of suture thread **T** in contact with ridge **134** conforms around ridge **134** as suture thread **T** is pushed into groove **138**. The desired amount of tension is

maintained on suture thread **T** primarily by the interaction between ridge **134**, suture thread **T**, and the interior walls of groove **138**.

Figures 7-9 depict a portion of an alternate embodiment of a suture clip **700** in accordance with the invention. Clip **700** is identical to clip **100** (described above with reference to Figures 1-6) in every respect, with the exception of ridge **702** and eyelet **704**, which are shown in detail in Figures 7-9. In this embodiment, eyelet **704** extends transversely through ridge **702** perpendicular to the lengthwise direction of inner surface **108** of first leg **102**. Ridge **702** comprises an aperture or eyelet **704** that extends downwardly through the bottom of ridge **702** so as to define an open slot **704'** that extends from the bottom of ridge **702** into eyelet **704** to facilitate inserting suture thread **T** through eyelet **704**. As a result, ridge **702** has a generally U-shaped profile, which facilitates the placement of clip **700** around suture thread **T**. For example, clip **700** may be applied to suture thread **T** after suture thread **T** has been used to secure tissue.

As in the previous embodiment, clip **700** secures suture thread **T** in a manner similar to clip **100**. As shown in Figure 9, when clip **700** is applied to a portion of suture thread **T**, ridge **702** pushes suture thread **T** into groove **138**. The portion of suture thread **T** in contact with ridge **702** conforms around ridge **702** as suture thread **T** is pushed into groove **138**. The desired amount of tension is maintained on suture thread **T** primarily by the interaction between ridge **702**, suture thread **T**, and the interior walls of groove **138**.

Accordingly, the objects of the invention have been fulfilled by providing a surgical clip that may be used to secure the ends of a suture while maintaining a desired amount of tension on the suture.

It will be understood that various details of the invention may be changed without departing from the scope of the invention. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation—the invention being defined by the claims.